EO-1 ICD-070
Baseline
November 22, 1999

EARTH OBSERVING 1

DATA INTERFACE CONTROL DOCUMENT

FOR

LEISA/AC TO EO-1 SCIENCE DATA PRODUCTS

November 22, 1999

EO-1 ICD-070
Baseline
November 22, 1999

EARTH OBSERVING 1

DATA INTERFACE CONTROL DOCUMENT

FOR

LEISA/AC TO EO-1 SCIENCE DATA PRODUCTS

APPROVED:

LEISA/AC:

________________________________	________________________________
George McCabe	Dennis Reuter
Date approved: ________________	Date approved: ________________

NASA Goddard Space Flight Center:

________________________________	________________________________
Peter Spidaliere	Daniel Mandl
Date approved: ________________	Date approved: ________________
________________________________	________________________________
Steven Ungar	Nicholas Speciale
Date approved: ________________	Date approved: ________________
________________________________	
Lawrence Alexander	
Date approved: ________________	

Change Information Page

List of Effective Pages	
Page Number	**Issue**

Revision	Description	Date	Approval
-	Initial Release	11/22/99	

Table of Contents

Table of Figures

1 Introduction

The Earth Observer 1 (EO-1) spacecraft will carry the LEISA Atmospheric Corrector (AC) sensor for Earth resources imaging and to correct high spatial resolution multi-spectral imager data (ALI and LandSat) for the effects of atmospheric transmission. The AC will collect data with three focal plane arrays, and output the data to a single data port. The AC records hyperspectral data from ~ 0.9 to 1.6 μm over a swath width of 185 km at a single pixel resolution of 250 meters.

The AC calibration system (ACCS) is designed to ensure a long-term radiometric calibration of 7 percent or better. There are six in flight calibration data sources: dark current, solar (through separate calibration apertures), lunar, deep space, known ground reflective surfaces, and comparison data form the ALI and Hyperion sensors on the EO-1 spacecraft. Radiometric calibration may use all of these sources or a subset of these sources to convert digital numbers received from the focal plane arrays to engineering units of radiance. Spectral calibration will use the Earth's atmospheric spectra as well as some strong Fraunhoffer lines measured during solar and lunar calibration scans.

1.1 Overview of EO-1/AC Data Collection

The data output by the AC port will be collected during data collection events (DCEs). An AC DCE is defined as instrument on to instrument off. The AC focal plane arrays collect data in a two-dimensional push broom fashion, and DCEs can vary in duration. There are two types of AC DCEs, Science and Calibration. Science DCEs refer to data collected while looking at the Earth, even if there is a calibration target in the scene on the ground. Calibration DCEs refer to data collected on the Sun, on the Moon, on deep space, or on the unlit side of the Earth (dark current calibration) or from some other calibration source (other than the Earth) for radiometric calibration purposes.

The spacecraft's Wideband Advanced Recorder/Processor (WARP) reads the data coming from the AC and stores it in onboard memory for downloading when over a ground contact at a later time. Housekeeping data collected during the DCE will also be stored in the WARP. All data stored in the WARP will be downloaded via the X-band link. Housekeeping data is also collected between DCEs and stored in the EO-1 spacecraft's command processor and is downloaded during ground contacts via the S-band link. Imaging data stored in the WARP from science and calibration DCEs may be transmitted over S-band as well.

1.2 Overview of EO-1/AC Ground Data Processing

Level 0 data processing is done by the EO-1 Data Processing System (DPS) in the Mission Operations Center (MOC) with computer programs provided by the AC instrument team (ACIT). During the Early Orbit Checkout (EOC) period, Level 1 and other subsequent processing of the data is done by the AC instrument team using the ACCS. The Level 1 processing procedures will be refined during this time and the algorithms will be provided to the Science Validation Facility (SVF). Ground data processing has three major parts: Level 0 processing; Level 1R (Radiometric Calibration processing), and post-processing, which includes both performance assessment and possible SVF processing other than Level 1R. The data flow between these three major parts is described below and outlined in Figure 1.

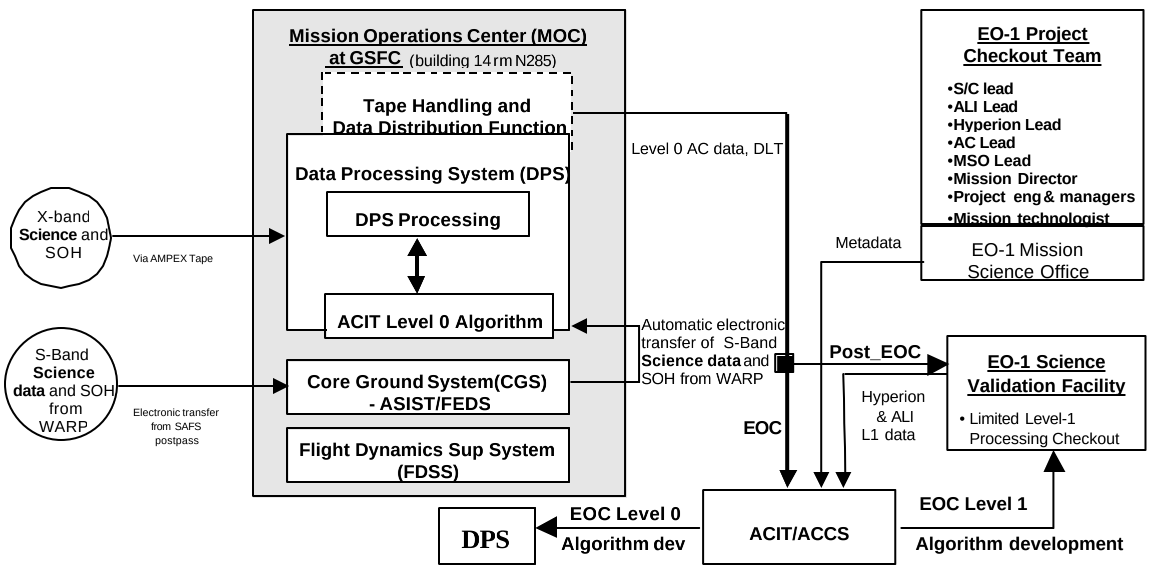

Figure 1: Science Data Flow for the Ground Data Processing for the EO-1

The AC spectral data, along with spacecraft and AC housekeeping telemetry data collected during DCEs, will be downloaded from the EO-1 spacecraft's WARP via an X-band link during ground station contacts. Housekeeping data collected between DCEs is stored in the command processor and will be downloaded over an S-band link, along with real-time housekeeping data generated during the ground station contact. Housekeeping data generated during a DCE is also stored on the WARP, and is included in the Level 0 data. All downloaded data will be stored temporarily on tape at the ground station, then sent to GSFC where it will be stored on disk for all ground data processing. The only parameter trended for the AC from the S-band housekeeping data is the temperature in the interface panel between the AC optics module and the spacecraft.

The DPS receives the data packets after the downlink. It removes the channel coding and reassembles the science data, performing pixel re-ordering of the science data into images in band-interleaved order. All housekeeping data will be put into ASIST-compatible SFDU format and into IDL compatible format. The spectral and DCE housekeeping data files will be put into the Level 0 format defined below and then made available to the ACCS.

Radiometric calibration will be done by the ACCS producing Level 1R data when requested. During EOC this will be done by the AC instrument team and afterward by the SVF with algorithms developed by the AC instrument team. During EOC, requests to the SVF for Level 1R data will be communicated to the AC instrument team. The ACCS reads the Level 0 data that includes, at a minimum, science DCEs with dark frame data. The Level 0 data set may also include any of three types of calibration DCEs: solar, lunar, or astronomical. The calibration will generate a Level 1R AC science file for each Level 0 AC science and calibration file. The Level 1R files will contain the calibration coefficients used for each pixel so that the Level 0 data can be recovered from the Level 1R files. These files are put into the agreed upon Level 1R format and written to an SVF disk for distribution by the SVF. During EOC the Level 1R data will be transferred to the SVF from the AC instrument team on tape media. The AC instrument team will maintain an archive of the calibration database and calibration processing notes.

All the Level 0 data are written to tape for delivery to the AC instrument team. During EOC the ACIT will evaluate the performance of the radiometric calibration system as well as the general spectral and spatial performance of the AC using Level 0 data. For proper performance assessment, all available data products must be included in the analysis. These products include the ALI and Hyperion Level 1 data and any improved ephemeris or attitude data generated by the ground processing system, in addition to the previously mentioned Level 0 and housekeeping data from both during and between DCEs. During EOC the MOC will write these data to tape for delivery to the AC instrument team.

1.3 Applicable Documents

The documents listed below offer additional information on the EO-1 data processing system and the Hierarchical Data Format (HDF), which is used for all exchanged data files.

1. EO-1 to AC Interface Control Document.

2. AC to WARP Interface Control Document.

3. EO-1 Space to Ground ICD, dated September 24, 1998

4. EO-1 Mission Operations Center (MOC) to Mission Science User Working Group (MSUWG) Interface Control Document, Version 3, April 6, 1999.

5. EO-1 ICD for Radiometric Calibration Processing & Performance Assessment Processing between NASA/GSFC and MIT/LL, Document 005, dated November 2, 1998.

6. EO-1 Project TRW/GSFC Data Interface Control Document, No. HYPER.99.600.004, dated June 4,1999.

7. Earth Orbserving-1 (EO-1) Memorandum of Understanding between Mission Operations Center (MOC) and Flight Dynamics Facility (FDF) Orbital and Mission Aids Transformation System (FORMATS), Revision 1, April 20, 1999

8. National Center for Supercomputing Applications (NCSA) HDF Development Group, *HDF User's Guide* , June 4, 1997. URL:http://hdf.ncsa.uiuc.edu/doc.html

9. NCSA HDF Development Group, *HDF User's Reference Manual v4.1r1*, Draft June 9, 1997. URL:http://hdf.ncsa.uiuc.edu/doc.html

10. NCSA HDF Development Group, *HDF Specification and Developer's Guide, Version 3.2*, September 1993. URL:http://hdf.ncsa.uiuc.edu/doc.html

2 Document Coordination

Document changes will be coordinated through designated persons. Currently they are:

GSFC:	S. Ungar,	(301) 286-4007,	E-mail: stephen.g.ungar.1@gsfc.nasa.gov
	L. Alexander,	(301) 286-9686,	E-mail: lalexand@pop700.gsfc.nasa.gov
	D. Mandl,	(301) 286-4323,	E-mail: daniel.j.mandl.1@gsfc.nasa.gov
	R. Reider,	(301) 286-6501,	E-mail: richard.p.reider.1@gsfc.nasa.gov
AC:	G. McCabe,	(301) 286-8283,	E-mail: george.mccabe@gsfc.nasa.gov
	D. Reuter,	(301) 286-2042,	E-mail: dennis.reuter@gsfc.nasa.gov

All additions and changes to this interface control document (ICD), after it is approved, will be appropriately marked in this document and recorded in the change log at the beginning of this document.

3 Data Exchange

All data transferred from the MOC to the ACIT will be by tape media. During EOC, all data products sent from the ACIT to the SVF will be transferred via tape media. All data files used for performance assessment will be transferred for the duration of the mission using tape media.

3.1 Tape Media Specification

The baseline tape will be an uncompressed Digital Linear Tape (DLT) compatible cartridge, 35-GB capacity, for a DLT7000 tape drive. File formats and naming conventions are defined later in this document. The files will be written to the tape with the UNIX *tar* command. The blocksize of the archive program is 320x512 bytes. Upgrades to higher density media or change to use of compressed format will be made upon concurrence of both the MOC and the AC instrument team.

Each individual tape will contain one or more DCE file sets. A DCE file set will consist of all files, science, housekeeping, ground processing, etc., associated with a DCE. No file or DCE file set will be split across tapes. Non-DCE housekeeping files will be written on a separate tape.

Each tape will be accompanied by a hardcopy list of its contents, including file name, file size (in bytes), total bytes used, and any applicable processing notes. The files will be listed in the order that they are stored on the tape. The content list will also be stored on the tape in an ASCII file. No extra filemarks, set marks or partitioning will be on the tape. Tape contents and labeling specifics are defined in the EO-1 Mission Operations Center (MOC) to Mission Science User Working Group (MSUWG) Interface Control Document.

3.2 AC Address

Tapes shall be mailed or sent to the AC instrument team at the following address:

George McCabe
NASA/GSFC Code 693
Bldg 2, Room 151
Greenbelt, MD 20771
Voice: (301) 286-8283
E-mail: george.mccabe@gsfc.nasa.gov

4 Data Product Definitions

This section defines the intermediate data products of the EO-1 ground data processing. It is divided into three sections. Section 1 describes the Level 0 data products output from the MOC DPS by its Level 0 Processor, and input to the AC Level 1R Radiometric Calibration System. Section 2 describes the Level 1R data products output from the AC Instrument Team-developed ACCS. During EOC, Level 1r products will be produced by the ACIT and transferred to the SVF. After EOC, the Level 1R products will be produced by the SVF using the ACCS developed by the ACIT. Section 3 describes additional data files necessary for accurate performance assessment that are neither an input to nor an output from the ACCS.

All data products will be in HDF with the exception of the SFDU-formatted housekeeping data. The Level 0 input data products and the Level 1R output data products will be a collection of data files generated with HDF scientific data (SD) application programming interfaces (APIs). Each independent data port will correspond to a single SD file for the Level 0 input data. Each input SD file from a science DCE will have a corresponding output SD file.

Each SD file contains two major parts: the file header and the data objects. The file header information contains a number of attributes. Each attribute consists of an attribute name, an attribute count defining the length of the attribute information, and an attribute type. An example of an attribute is the filename. The attribute would be called 'Filename', would be of type DFNT_CHAR8, and would contain 21 bytes, e.g., EO11997365235959.ACZ. A data object contains a multi-dimensional scientific data set (SDS), e.g. a three dimensional set of elements, and a data descriptor block defining the type of data, its location in the file, and the length of the data. Each SDS can have its own set of attributes in addition to the attributes that are part of the file header. The Level 1R calibrated output data files will have multiple SDSs: one for the Level 1R data, one for the dark offset coefficients, and one for the response coefficients.

4.1 Level 0 Data Products

The following subsections describe the data output from the MOC DPS Level 0 Processor and input to the AC Calibration System. The first three sections describe the data bit order and pixel order. The remaining sections describe the Level 0 files and the input to the AC calibration system.

Figure 2 shows the data content of a frame's worth of data as transmitted to the WARP.

4.1.1 Level 0 Data Processing

The output from level zero processing will be in the form of three successive band-interleaved images corresponding to the three detectors. This allows the state of health of the system to be estimated by inspection of the images.

4.1.1.1 Bit Order

The science and calibration data are output from the DPS Level 0 Processor as 16-bit words with 12 bits of precision. The four most significant bits (MSBs) may be used to indicate processing features. The bit order of the LZP should be that the least significant bit (LSB) of a pixel value should correspond to the LSB of the 16-bit word, and the MSB of a pixel value should correspond to the 12th MSB of the 16-bit word. For example, the following line of C code should be true: PixelValue = (0xfff & PixelValue) where PixelValue is the 16-bit data word.

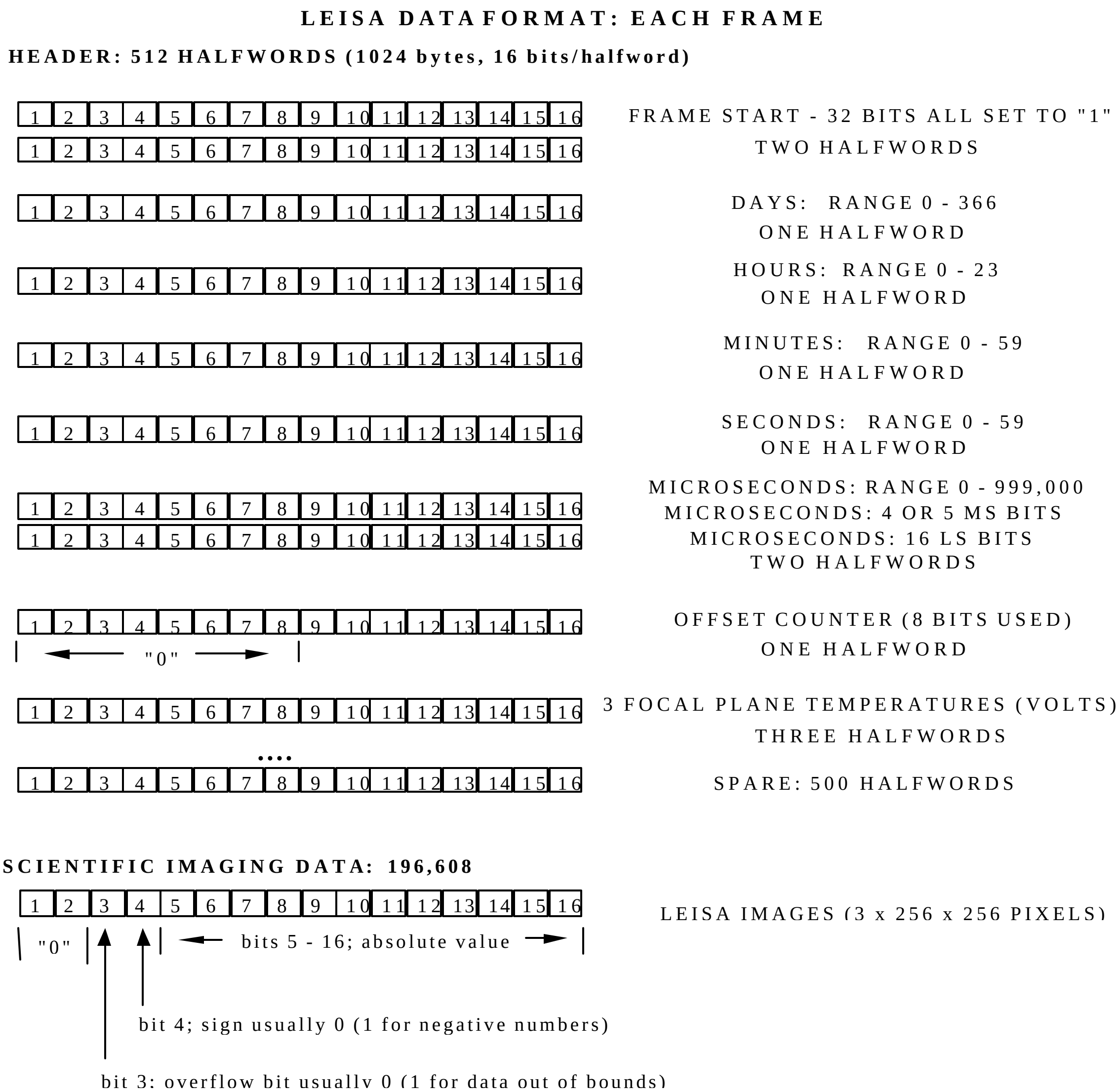

Figure 2: **AC bit data order for each frame as transmitted to the WARP. Note that each frame of science data contains state of health information.**

4.1.1.2 Pixel Order

A single AC Hyperspectral image frame is obtained using three 256 x 256 element arrays simultaneously. In front of each array is a wedged filter. The transmission pass-band of this filter varies along one dimension. This effectively creates an array of 256 constant wavelength rows of 256x3 pixels each. The wavelength variable direction is designed to be parallel to the direction of travel of the spacecraft. A spectrum of each point on the ground is created as an image of that point is swept along a column of the array by the motion of the spacecraft. Figure 3 is a schematic of the orientation of the image on the arrays with respect to the spacecraft motion and the wavelength variability.

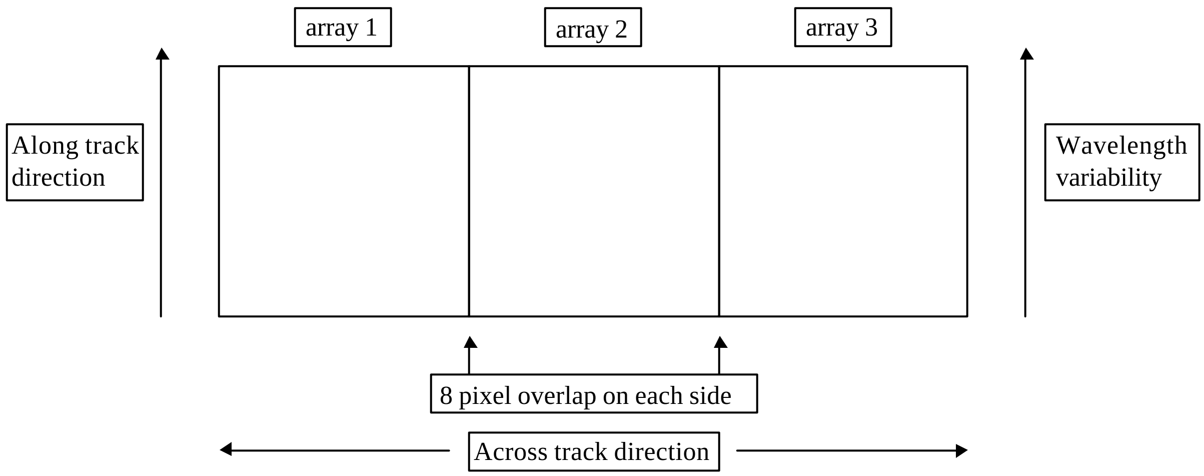

Figure 3: Schematic of focal plane showing orientation of image on three arrays with respect to direction of wavelength variation and spacecraft motion.

A frame of data corresponds to a read-out of the pixels in all three arrays. The order in which data is read from a given array is illustrated in the following Figure 4.

Each array has four output amplifiers, so that four pixels are read out on each clock cycle and the array is separated into four "quadrants", q1 - q4. Each quadrant consists of 256 rows of 64 pixels each. Pixels are read starting from the bottom left-hand corner of each quadrant. Each 64 pixel row in a quadrant is read from left to right, while the 256 rows are read from the bottom to the top of the array.

Labeling each pixel in an array as (i,j) where *i* is the row index and *j* is the column index we define (1,1) as the lower left hand corner of the array. For each array then, pixels are read out in groups of four as: [(i,j); (i,(j+64)); (i,(j+128)); (i,(j+192))], where *j* runs from 1 to 64 and *i* runs from 1 to 256. The value of *j* is incremented from 1 to 64 before *i* is incremented by one. Each pixel consists of two bytes, with the least significant 12 bits containing the image information. Data is output to the WARP in two pixel units. The data from the three arrays is interleaved in groups of 512 pixels. That is, 512 pixels from array 1 are followed by 512 from array 2 and 512 from array 3. This sequence is repeated until 65,536 pixels are read from all three arrays (corresponding to 196,608 pixels per frame). At the beginning of each frame a 1024 byte header containing times and status information is inserted into the science data. In the event that a given block of data is lost, or if data errors are too numerous to allow Reed-Solomon correction fill pixels with the value "C000" shall be inserted into the data stream.

The Level 0 processing will reorder the image data into three successive band interleaved array images.

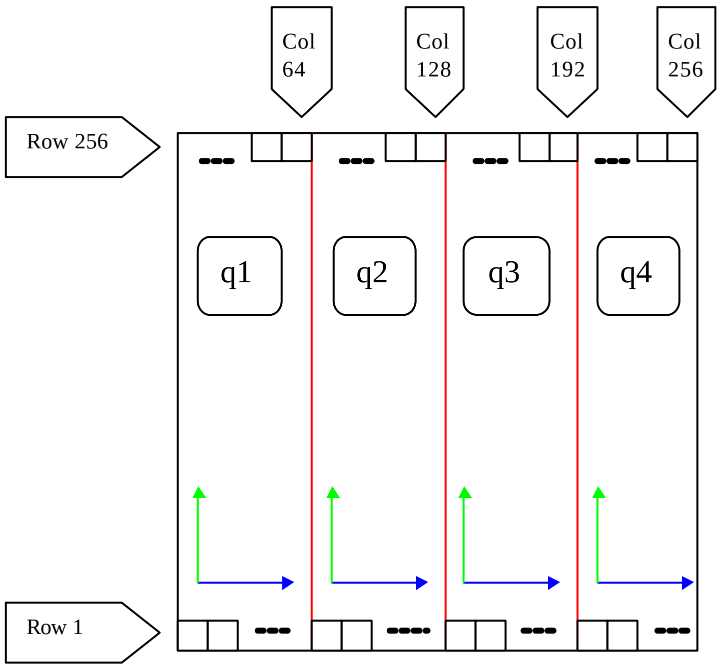

Figure 4: Order of array read-out (only a few pixels are illustrated). Pixels are read from 4 outputs, one each for 4 256x64 pixel 'quadrants'. The blue direction is constant wavelength (across-track), and green is the variable wavelength direction (along-track). A swath on the ground imaged in the 1st row will be imaged in the 256th row 256 frames later. A full spectrum is obtained by combining the data in all frames 1 to 256.

4.1.1.3 Accuracy and Completeness

Data completeness will be as high as possible, with all available data processed. The actual level of data completeness will be identified within the production data files through the specification of byte locations of data fill pattern.

4.1.1.4 Maximum File Size

Data files will be recorded from the AC port at a rate of either 28 or 56 Hz, depending on the value of the command adjustable frame rate. This corresponds to 5,519,360 pixels per second @ 28 Hz and 11,038,720 pixels per second @ 56 Hz. Assuming 1 kB of attributes and a 30-second DCE, the total file size for a single will be approximately 330 MB for a science DCE @ 28 Hz and 660 MB for a science DCE @ 58 Hz. Each of the various calibration DCE files will be no larger than a 30-second science DCE file and may be substantially smaller.

.

4.1.2 Support Duration

The MOC DPS will generate this file through all mission phases. This file shall be sent to the AC instrument team throughout the duration of the flight. After the EOC phase the Level 0 data shall be sent to the SVF.

4.1.3 Format

Filename: ACyyyydddhhmmss.L0

The **yyyydddhhmmss** time will be the start time of the DCE generating the science data present in the file.

File Attributes:

Name	Max. Length	HDF Type	Example value
Filename	21	DFNT_CHAR8	"ACyyyydddhhmmss.L0"
Data Product Level	1	DFNT_INT16	0
LZP Software Version	3	DFNT_INT16	1,1,1 (Version 1.1.1)
Big (1) or Little (0) Endian	1	DFNT_INT16	1
Time of File Generation	14	DFNT_CHAR8	"yyyydddhhmmss"
Number Related Files	1	DFNT_INT16	4
Related File 1	21	DFNT_CHAR8	"EO1yyyydddhhmmss.DHZ",
Related File 2	21	DFNT_CHAR8	"EO1yyyyddd_vvvvssss_r1.L0",
Related File 3	21	DFNT_CHAR8	"ALIyyyydddhhmmss.L0",
Related File 4	21	DFNT_CHAR8	"EO1yyyydddhhmmss.NHZ",
Level 0 Processing Notes	N	DFNT_CHAR8	N bytes of string data

SDS Attributes for Level 0 data:

Name	Max. Length	HDF Type	Example value
Dataset Type	12	DFNT_CHAR8	"SCIENCE"
Data Start Time	14	DFNT_CHAR8	"yyyydddhhmmss"
Data Duration	1	DFNT_FLOAT32	12.12345 (in seconds)
Number of complete frames	1	DFNT_INT32	1200
Percent Missing Data	1	DFNT_INT16	11

Acceptable entries for "Dataset Type" include "SCIENCE" for normal DCE's, "DARK" for dark frames, "SOLAR" for solar calibration DCE's , "LUNAR" for lunar calibration DCE's and "ASTRONOMICAL" for calibration DCE's using astronomical sources.
The file identified as "EO1yyyyddd_vvvvssss_r1.L0" is the Level 0 Hyperion data file as defined in Reference Document 6, while the file identified as"ALIyyyydddhhmmss.L0" is the Level 0 ALI data as defined in Reference Document 5. The file identified as "EO1yyyydddhhmmss.DHZ" is the DCE housekeeping data stored in the WARP and transmitted down by the X-band and defined in Reference Document 4

4.1.4 DCE Housekeeping File (DHZ)

4.1.4.1 Description

This file contains the housekeeping telemetry data collected by the WARP during a DCE. This file is included on the Level 0 data tape created for the ACCS and the file name, the parameters included and the format are defined in Reference Document 4.

4.1.4.2 Support Duration

The MOC DPS will generate this file through all mission phases. This file shall be sent to the AC instrument team throughout the duration of the flight.

4.1.4.3 Format

Filename: EO1yyyydddhhmmss.DHZ

The **yyyydddhhmmss** time will be the start time of the DCE during which the housekeeping data was collected.

File Format: The housekeeping data will be in the standard ASIST-compatible SFDU format as defined in Reference Document 4.

4.1.4.4 Accuracy and Completeness

Data completeness will be as high as possible, with all available data processed.

4.1.4.5 Maximum File Size

[TBD]

4.2 Level 1R Radiometrically Calibrated Data Products

The following subsections individually describe each data product that will be output from the ACIT-developed Level 1R ACCS. During EOC, these data files will be produced by the AC instrument team and will be sent to the SVF. After EOC, the ACCS will be integrated with the SVF, and the level 1R calibration will be performed there. The data will reside on a GSFC SVF disk and will also be written to tape for use by the AC instrument team for performance assessment. These data files will be generated when requested and may not be generated for all Level 0 data files.

4.2.1 AC Level 1R Radiometrically Calibrated Data Files

4.2.1.1 Description

These files contain the radiometrically calibrated data generated from the Level 0 files of raw AC data collected by the WARP from the AC port during a DCE. The DCE can be either calibration or science data.

Each file contains the Level 0 file attributes with some modification, plus additional attributes associated with the radiometric calibration. The output data for each focal plane array is stored as one SD file with five SDSs: the 16-bit scaled integer Level 1R calibrated data for the AC, the 16-bit floating point dark offset coefficients applied to the Level 0 data, the 16-bit floating point response coefficients applied to the Level 0 data, the 16-bit integer pixel map and the 16-bit floating point pixel wavelength map. The pixel map is a (256 x 768 x 2) element array which gives the relative angular along-track and across-track position of each pixel in microradians. The first dimension is the along track dimension while the second is the across track dimension. That is, the (n,m,1) element defines the along track angular displacement of pixel (n,m) while the (n,m,2) element defines the across track angular displacement of pixel (n,m). The (1,1,1) and (1,1,2) elements are defined to be at zero offset. Pixels which are identified as non-functional will be given a value of -1 for both elements. The pixel wavelength map specifies the center wavelength, the shortwave half- power point and the longwave half-power point for each pixel. It has dimension (256 x 768 x 3).

To recover the Level 0 data for a pixel, first divide the Level 1R engineering unit value by the response coefficient for that pixel, then add in the dark coefficient for that pixel.

4.2.1.2 Support Duration

The SVF will generate these files when requested through all mission phases. During the EOC period, these files will be produced by the AC instrument team and transferred to the SVF on a DLT. After EOC, these files will be produced by the SVF using algorithms delivered by the AC instrument team.

4.2.1.3 Format

Filename: ACyyyydddhhmmss.L1R

The **yyyydddhhmmss** time will be the start time of the DCE that generated the data present in the file.

File Attributes:

Name	Max. Length	HDF Type	Example value
Filename	21	DFNT_CHAR8	"ACyyyydddhhmmss.L1R"
Data Product Level	1	DFNT_INT16	1
LZP Software Version	3	DFNT_INT16	1,1,1 (Version 1.1.1)
Big (1) or Little (0) Endian	1	DFNT_INT16	1
Time of File Generation	14	DFNT_CHAR8	"yyyydddhhmmss"
Type of DCE	12	DFNT_CHAR8	"SCIENCE",”DARK”, “SOLAR”, “LUNAR”, or “ASTRONOMICAL”
Number Related Files	1	DFNT_INT16	1
Related File 1	21	DFNT_CHAR8	"ACyyyydddhhmmss.L0",
Level 0 Processing Notes	N	DFNT_CHAR8	N bytes of string data
Calibration Software Version	3	DFNT_INT16	1,1,1 (Version 1.1.1)
Calibration Processing Notes	N	DFNT_CHAR8	N bytes of string data

SDS Attributes for Level 1R data:

Name	Max. Length	HDF Type	Example value
Dataset Type	12	DFNT_CHAR8	"Level 1R"

Data Start Time	14	DFNT_CHAR8	"yyyydddhhmmss"
Data Duration	1	DFNT_FLOAT32	40.12345 (in seconds)
Number of frames	1	DFNT_INT16	1200
Percent Missing Data	1	DFNT_INT16	11

SDS Attributes for offset coefficient data:

Name	Max. Length	HDF Type	Example value
Dataset Type	12	DFNT_CHAR8	"Offset"
Level 0 "DARK" filename	21	DFNT_CHAR8	"ACyyyydddhhmmss.L0",
Scale factor	1	DFNT_INT16	1000

SDS Attributes for response coefficient data:

Name	Max. Length	HDF Type	Example value
Dataset Type	12	DFNT_CHAR8	"Response"
Level 0 "SOLAR" filename	21	DFNT_CHAR8	"ACyyyydddhhmmss.L0"
Level 0 "LUNAR" filename	21	DFNT_CHAR8	"ACyyyydddhhmmss.L0",
L0 "ASTRONOMICAL" fn	21	DFNT_CHAR8	"ACyyyydddhhmmss.L0",
Scale factor	1	DFNT_INT16	1000

SDS Attributes for pixel map:

Name	Max. Length	HDF Type	Example value
Dataset Type	12	DFNT_CHAR8	"Pixel Map"
Number of bad pixels	1	DFNT_INT16	320

SDS Attributes for pixel wavelength map:

Name	Max. Length	HDF Type	Example value
Dataset Type	12	DFNT_CHAR8	"Wavelength Map"

4.2.1.4 Data Format

The data will be in a three-dimensional array: x cross track, y along track, and z in the spectral band dimension. The array will consist of images for each band in band-sequential order, and each image will be written in row major format with each row corresponding to the cross track direction. Described heuristically, the data array will consist of all the cross track pixels for the first frame in a single band, followed by all the cross track pixels for the next frame in the same band, and so on for all frames in a DCE. This is repeated for each band. There are 256 bands. Fill values of "C000" in the level 0 data will be transferred to level 1 without modification.

For example, if 1200 frames are obtained the level 1 array will be of dimension (768 x 1200 x 256) since there are 768 cross track pixels and 256 bands. The order of the (x, y, z) data array will be:

```
( 1,    1,   1),…………………( 768,    1,   1),
( 1,    2,   1),…………………( 768,    2,   1),
   ⋮                            ⋮
( 1,1200,    1),………………..( 768,1200,    1),
( 1,    1,   2),…………………( 768,    1,   2),
( 1,    2,   2),…………………( 768,    2,   2),
   ⋮                            ⋮
( 1,1200, 256),……………….( 768,1200, 256)
```

The dark offset and response coefficient matrices will both be of dimension 768 x 256 and will consist of single values for each pixel. The x dimension data will be the cross track dimension and the y dimension data will be the along track dimension

The coefficient data array will have the form:

```
( 1,   1),………………..…(768,   1),
( 1,   2),………………….(768,   2),
 ⋮                  ⋮
( 1, 256),…………………(768, 256)
```

The pixel map is a (256 x 768 x 2) element array which gives the relative angular along-track and across-track position of each pixel in microradians. The pixel map array will have the form:

```
( 1,   1,   1),………………..…(256,   1,   1),
( 1,   2,   1),………………….(256,   2,   1),
                    M
( 1, 768,   1),………………..…(256, 768,   1),
( 1,   1,   2),……………….....(256,   1,   2),
```

⋮
(1, 768, 2),…………………(256, 768, 2)

The pixel wavelength map specifies the center wavelength, the shortwave half power point and the longwave half-power point for each pixel. It has dimension (256 x 768 x 3).

The pixel map array will have the form:

(1, 1, 1),…………………(256, 1, 1),
(1, 2, 1),…………………(256, 2, 1),
⋮ ⋮
(1, 768, 1),…………………(256, 768, 1),
(1, 1, 2),…………………(256, 1, 2),
(1, 2, 2),…………………(256, 2, 2),
⋮ ⋮
(1,768, 3),…………………(256, 768, 3)

4.2.2 Calibration System Processing Log File (PLR)

4.2.2.1 Description

This file contains the processing log generated by the ACCS for a single DCE. It combines all processing notes for each science data port in a single file.

4.2.2.2 Support Duration

The SVF will generate this file when requested through all mission phases. For the EOC period of the mission, this file will be created by the AC instrument team. For the duration of the mission, this file will be created by the SVF.

4.2.2.3 Format

Filename: ACyyyydddhhmmss.PLR

The **yyyydddhhmmss** time will be the start time of the DCE that generated the data present in the file.

Format: All information will be stored as ASCII text.

4.2.2.4 Accuracy and Completeness

The data in the file shall always be accurate and complete.

4.2.2.5 Maximum File Size

This file should be less than 10 kB.

4.2.2.6 File Access

Data will reside on a GSFC SVF disk.

4.3 Non-Calibration System Data Files

The following subsections individually describe the data files necessary for accurate performance assessment that are neither an input to nor an output of the ACCS. They include the trended, non-DCE SOH data transmitted by the S-band system. These files will be written to tape by the either MOC DPS or SVF for use by the AC instrument team. Also detailed below is a tape contents file, which specifies which data files are being delivered on a given tape.

4.3.1 Non-DCE Housekeeping File (NHZ)

4.3.1.1 Description

This file contains the housekeeping telemetry data collected by the EO-1 spacecraft's command processor between DCEs and during real-time ground station contacts. Its name, contents and format are defined in Reference Document 4.

4.3.1.2 Support Duration

The MOC DPS will generate this file through all mission phases. Non-DCE housekeeping files not yet delivered by tape will be available electronically by ftp in the event immediate assistance or analysis is needed. The necessary pathname and access code will be defined at the time of such an event.

4.3.1.3 Format

Filename: EO1yyyydddhhmmss.NHZ

The **yyyydddhhmmss** time will be the start time of the download of the data during the ground station contact.

File Format: The housekeeping data will be in the standard ASIST-compatible SFDU format as defined in Reference [TBD].

4.3.1.4 Accuracy and Completeness

Data completeness will be as high as possible.

4.3.1.5 Maximum File Size

[TBD]

4.3.2 Ground Processing Data Files (GPZ)

4.3.2.1 Description

This file may never exist. If this file exists, this file contains the improved EO-1 spacecraft attitude and ephemeris data generated by MOC ground processing. This data is generated from the attitude and ephemeris data downloaded in the DCE housekeeping file. The name, contents and format of this file is defined in Reference Document 4.

4.3.2.2 Support Duration

The MOC will generate this file through all mission phases if any improved spacecraft attitude and ephemeris data exists.

4.3.2.3 Format

Filename: ACyyyydddhhmmss.GPZ

The **yyyydddhhmmss** time will be the start time of the DCE for which the ground processing data was generated.

Attributes and data format details will be determined if this data exists.

4.3.3 Tape Contents File (TCZ)

4.3.3.1 Description

This file contains a list of the files archived to tape. The tape contents file will appear first in the list and will be the first file in the tar file.

4.3.3.2 Support Duration

The SVF will generate this file through all mission phases.

4.3.3.3 Format

Filename: 0AC########.TCR

The ######## is the tape number. The leading 0 is to ensure that the file appears first in directory listings and tar files.

Format: All information will be stored as ASCII text in the following format and according to the following example:

Number of files: 5
0AC########.TCZ
ACyyyydddhhmmss.ACZ
ACyyyydddhhmmss.ACR
ACyyyydddhhmmss.IHZ
ACyyyydddhhmmss.DHZ

The integer specified in the **Number of files:** line will be a single number between 2 and 16.

4.3.3.4 Accuracy and Completeness

The data in the file shall always be accurate and complete.

4.3.3.5 Maximum File Size

Given that a maximum of 16 filenames will be on a single tape, this file should be less than 1 kB.

4.3.3.6 File Access

Data is transferred on DLT-compatible tape cartridge. A paper print out of this file will be sent with each Level 1R tape.

5 Appendix A

Variable Types

C	IDL	HDF
int	INT	DFNT_INT16
long	LONG	DFNT_INT32
float	FLOAT	DFNT_FLOAT32
char	BYTE	DFNT_CHAR8
string[]	STRING	DFNT_CHAR8

6 Abbreviations and Acronyms

AC	Atmospheric Corrector
ACCS	Atmospheric Corrector Calibration System
ACIT	Atmospheric Corrector Instrument Team
ALI	Advanced Land Imager
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
DCE	Data Collection Event
DLT	Digital Linear Tape
DPS	Data Processing System
EOC	early orbit checkout
EO-1	Earth Observer-1
GB	gigabyte
GSFC	Goddard Space Flight Center
HDF	Hierarchical Data Format
Hz	hertz

ICD	Interface Control Document
IDL	Interactive Data Language
KB	kilobyte
LSB	least significant bit
LZP	Level Zero Product
MB	megabyte
MIT	Massachusetts Institute of Technology
MOC	Mission Operations Center
MSB	most significant bit
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputing Applications
SD	scientific data
SDS	scientific data set
SFDU	standard formatted data unit
SVF	Science Validation Facility
TBD	to be determined
WARP	Wideband Advanced Recorder/Processor